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Gallium-67 Scans in the Diagnosis of Pyelonephritis

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Gallium-67 (^{67}Ga) citrate was administered intravenously (50 microcuries per kg of body weight) to patients in whom acute and chronic urinary tract infections were suspected. Scanning was done, using both the Anger-type scintillation camera and the rectilinear scanner, 24 to 78 hours after injection of the isotope.

The preliminary results imply that ^{67}Ga renal uptake is present in patients with pyelonephritis whether overt or silent, as well as in patients with ureterosigmoidostomies. However, ^{67}Ga renal uptake is not present in patients with radiographic evidence of chronic pyelonephritis without active infection and in patients without renal disease.

DISTINGUISHING UPPER FROM LOWER urinary tract infection has prognostic implications, may dictate the type and length of therapy, and may be a factor in determining the need for surgical intervention. The most reliable method for establishing the presence of upper tract infection is ureteral catheterization, but this is an invasive procedure and often requires the use of anesthesia and admitting the patient to hospital.

We report as a preliminary finding that selective renal uptake of gallium-67 (^{67}Ga) citrate occurs consistently in the presence of pyelonephritis, both overt and silent. Therefore, scintiphotography with this isotope may prove useful in differentiating between upper and lower tract infections.

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Methods

The usefulness of ^{67}Ga in searching for subphrenic abscesses has been reported previously.[1] After we noted the unexpected uptake of ^{67}Ga by the pyelonephritic kidneys of a patient being studied for a possible subphrenic abscess, a program was started in which 50 microcuries per kg of body weight of ^{67}Ga citrate was injected intravenously into patients in whom acute or chronic urinary tract infections were suspected.* Imaging was done at 24 to 78 hours after injection of the isotope, using both the Anger-type scintillation camera and the rectilinear scanner. Camera studies were done using the 184 KeV photopeak of ^{67}Ga with a 20 percent window and a medium energy diverging collimator. Normal uptake by the lumbar spine provided anatomic guidelines for interpretation of the scan. In the few instances where

*Gallium-67 citrate was provided by Mr. Harold Breslow of New England Nuclear, Billerica, Mass.

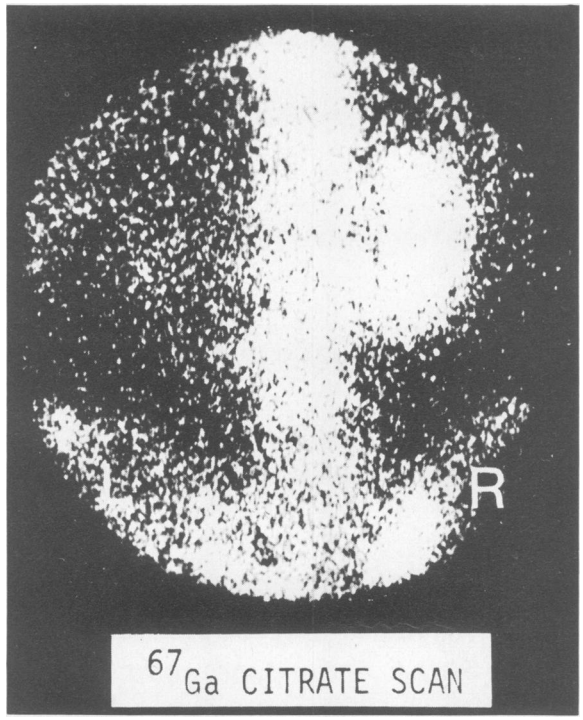

Figure 1.—Right renal uptake of gallium-67 in a patient with unilateral flank pain and pyelonephritis.

renal uptake was obscured by background activity, a kidney localizing dose of technetium 99m-DTPA was given.

Results

The results of ^{67}Ga isotope scans reviewed in this preliminary study are grouped as follows:

Retrospective Controls

Of all ^{67}Ga scans done as a tumor survey, 162 included the area of the kidneys. When reviewed for the purposes of the present study, there were only four patients with renal uptake of ^{67}Ga of these 162 patients. One of the four had hemochromatosis, and a second had chronic lymphocytic leukemia, but none had retrospective evidence of urinary tract infection. Therefore, in this series of incidental controls false positive results (such as uptake of ^{67}Ga in the absence of suspected pyelonephritis) were 2.5 percent.

Acute Pyelonephritis

This group was composed of 17 patients who all presented with overt signs of acute pyelonephritis. Renal uptake of ^{67}Ga was noted in all upon scanning. Sixteen of the 17 patient had urine cultures containing greater than 10^5 bacteria; the remaining patient had been treated with antibiotics 24 hours before obtaining the negative urine culture. Eleven of the patients had both unilateral flank pain and unilateral renal uptake of ^{67}Ga (Figure 1). Three patients with bilateral flank pain had bilateral isotope uptake, and three patients with unilateral flank pain had bilateral uptake with the greatest isotope concentration being localized to the side of the flank pain.

Silent Pyelonephritis

This group was composed of nine patients with pyuria and positive urine cultures without the typical picture of acute pyelonephritis. All of these patients had positive ^{67}Ga scans. In two of the patients, acute pyelonephritis was shown in biopsy specimens from the kidney and in three others positive results from Fairley washout tests suggested upper urinary tract infections.[2] Renal calculi were noted in a fifth patient (Figure 2), and the final three patients had a history of chronic urinary tract infections with at least two hospital admissions for sepsis.

Ureterosigmoidostomy

Four patients were studied in whom the drainage of urine had been diverted into the fecal stream by ureterosigmoidostomy. All of these patients had bilateral renal uptake of ^{67}Ga, although only one had overt acute pyelonephritis. In this patient, the ureterosigmoidostomy was converted to a bilateral ureteroileocutaneostomy because of repeated bouts of pyelonephritis and sepsis. His positive ^{67}Ga scan became negative after conversion of his urinary diversion.

Radiographic Pyelonephritis Only

Four patients with excretory urograms suggesting chronic pyelonephritis were studied. All four denied urinary tract infections for at least two months preceding the study, and the results of urine cultures were negative in all four. None of these patients had renal uptake of ^{67}Ga.

Discussion

Since Edwards and Hayes first reported the uptake of carrier-free ^{67}Ga in soft tissue tumors,[3] the isotope has become widely used in tumor evaluation[4] although the mechanism underlying the accumulation of ^{67}Ga has not been completely explained. Hayes et al.,[5] using autoradiography and electron microscopy, have demonstrated that ^{67}Ga accumulates in the lysosome-like organelles within cancer cells. Increased lysosomal activity, which is

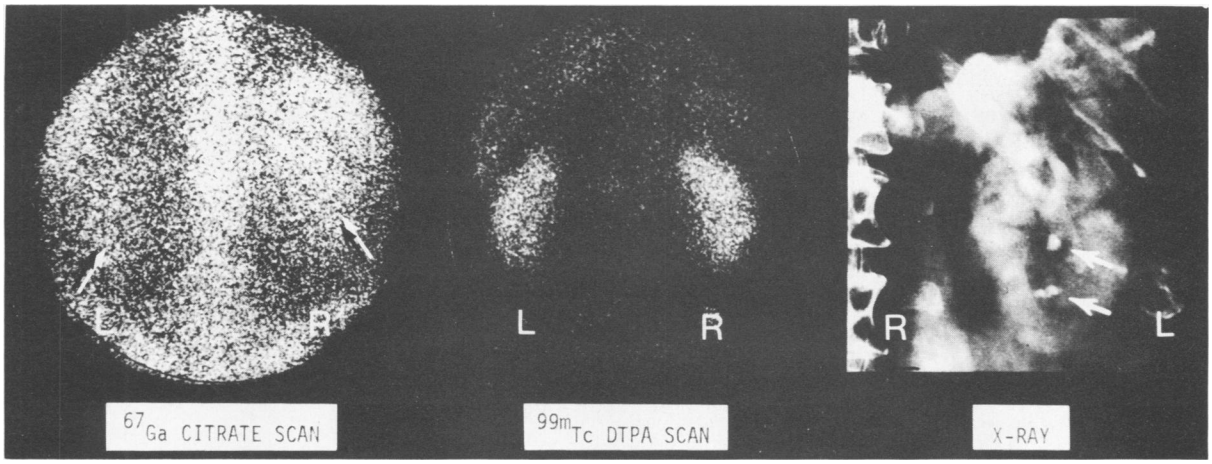

Figure 2.—A 54-year-old man with nephrolithiasis shown on pyelogram (right). ^{99m}Tc-DTPA was used to localize the kidney as seen in the middle scintiphoto. On gallium-67 imaging, renal uptake is indicated by the double arrows (left).

characteristic of inflammatory cells, may also account for the affinity of inflammatory lesions for ^{67}Ga. It has also been postulated that the lower pH in tumor tissue resulting from anaerobic glycolysis allows for the formation of more stable gallium-proteinate complexes.[6] This mechanism may also pertain to abscesses where the pH decreases with the increasing age of the lesion.[7]

The preliminary results of the present study imply that selective renal uptake of ^{67}Ga is present in all patients with overt acute pyelonephritis. The test is also positive in asymptomatic patients in whom the diagnosis of acute pyelonephritis is otherwise suggested by the finding of significant bacteriuria in association with biopsy-proven acute pyelonephritis, positive results from a Fairley washout test, or the presence of renal calculi.

Renal scans with ^{67}Ga are also consistently positive in patients with ureterosigmoidostomies, a group of patients in whom the diagnosis of upper urinary tract infections can only be inferred. These results support the laboratory findings of Harbach et al. that all animals with ureterosigmoidostomies evidenced some degree of acute pyelonephritis histologically.[8]

Finally, ^{67}Ga renal scans are consistently negative in patients with radiographic signs of chronic pyelonephritis but without active urinary tract infections.

We may conclude that ^{67}Ga renal scans are eminently useful in the diagnosis of acute pyelonephritis whether overt or silent. However, before one can consider that a scan is positive on the basis of inflammatory disease, all tumors of the kidney including Hodgkins' disease and leukemic infiltrates, must be ruled out.

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